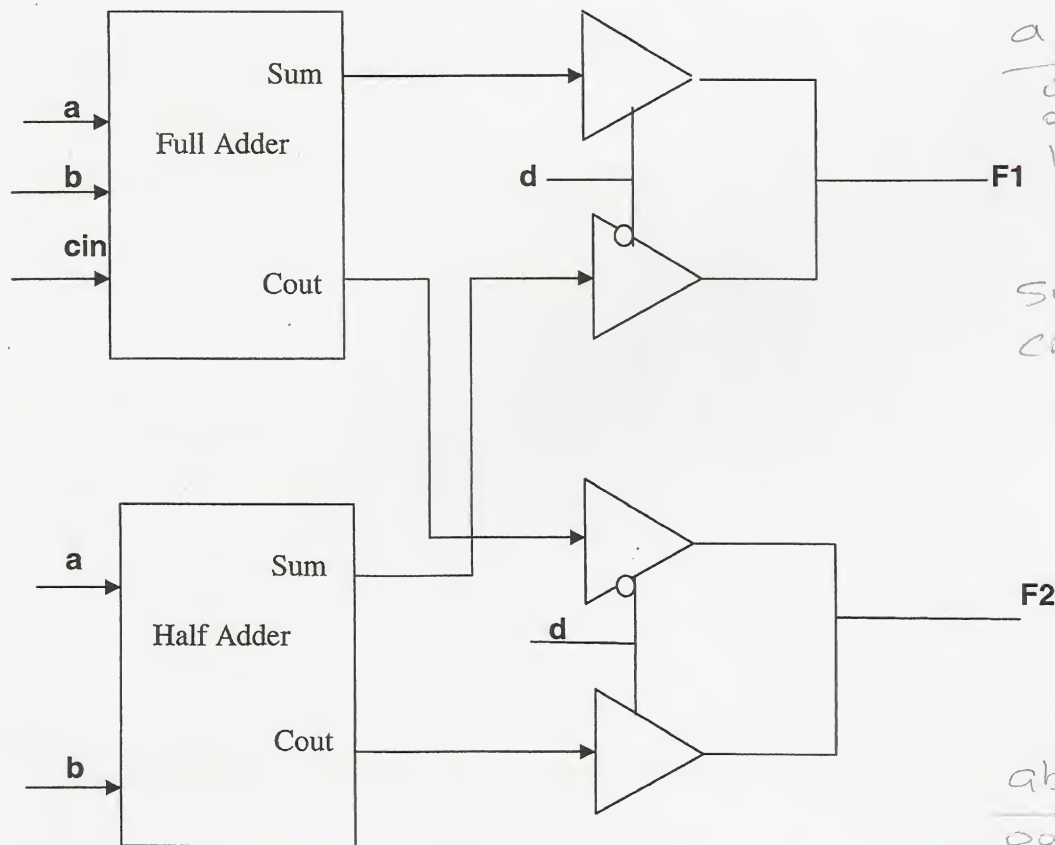


Question [1]: [12 mark]

Write the equations of the functions F1 and F2 generated by the following circuit.



H.A

a	b	sum	$cout$
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

$$Sum = a \oplus b$$

$$cout = ab$$

F.A

a	b	cin	sum	$cout$
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

Sum =

$$F_1 = (a \oplus b \oplus cin) \cdot d + (a \oplus b) \cdot \bar{d}$$

$$F_2 = (a + b \cdot cin) \cdot \bar{d} + (ab) \cdot d$$

$$Sum = \bar{a}\bar{b}cin + \bar{a}b\bar{c}in + a\bar{b}\bar{c}in + abcin$$

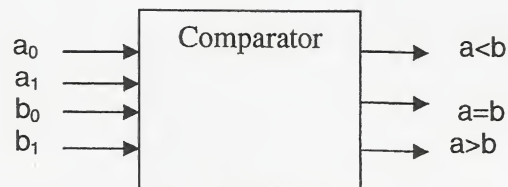
$$= \bar{a}(\bar{b}cin + b\bar{c}in) + a(\bar{b}\bar{c}in + bcin)$$

$$= a \oplus b \oplus cin$$

$$cout = a + b \cdot cin$$

Question [2] : [12 marks]

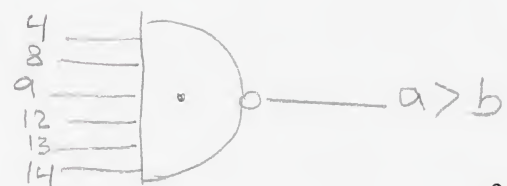
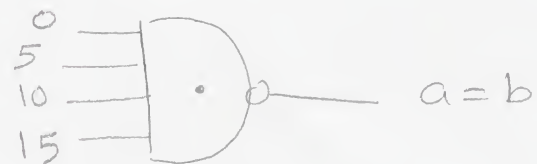
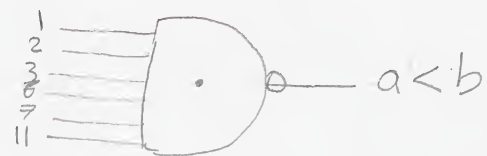
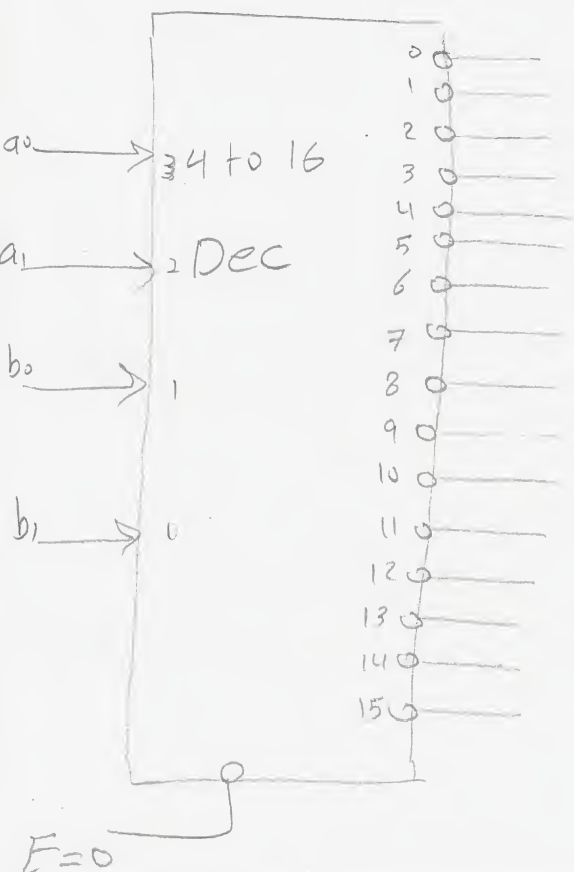
We want to design a 2-bit word comparator that compares the word $a = a_0 a_1$ with the word $b = b_0 b_1$.



1) Give the truth table of the comparator.

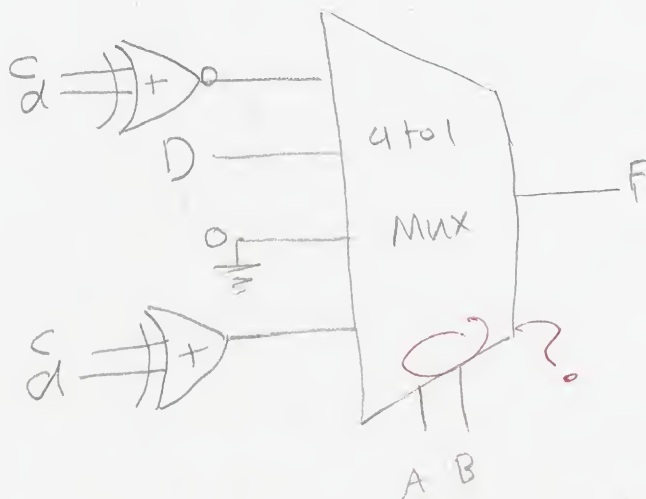
$a_0 a_1, b_0 b_1$	$a < b$	$a = b$	$a > b$
00, 00	0	1	0
00, 01	0	0	0
00, 10	0	0	0
00, 11	0	0	0
01, 00	0	0	0
01, 01	0	1	0
01, 10	0	0	0
01, 11	1	0	0
10, 00	0	0	1
10, 01	0	0	1
10, 10	0	1	0
10, 11	1	0	0
11, 00	0	0	1
11, 01	0	0	1
11, 10	0	0	1
11, 11	0	1	0

2) Implement the comparator with a decoder with inverted outputs and only NAND gates.



Question [3]: [12 marks]

- a. Implement $F = \Sigma m(0,5,13,14) + \Sigma d(3,7,11)$ with a 4 to 1 Multiplexer and a minimum number of gates.



\bar{c}	\bar{d}	c	d	F
0	0	0	0	1
1	0	0	0	0
0	0	0	1	0
1	0	0	1	X
0	1	0	0	0
1	1	0	0	1
0	1	0	1	0
1	1	0	1	X
0	0	1	0	0
1	0	1	0	0
0	1	1	0	0
1	1	1	0	X
0	0	1	1	0
1	0	1	1	1
0	1	1	1	0
1	1	1	1	0

$$I_0 = \bar{c}\bar{d} + cd$$

$$I_1 = D$$

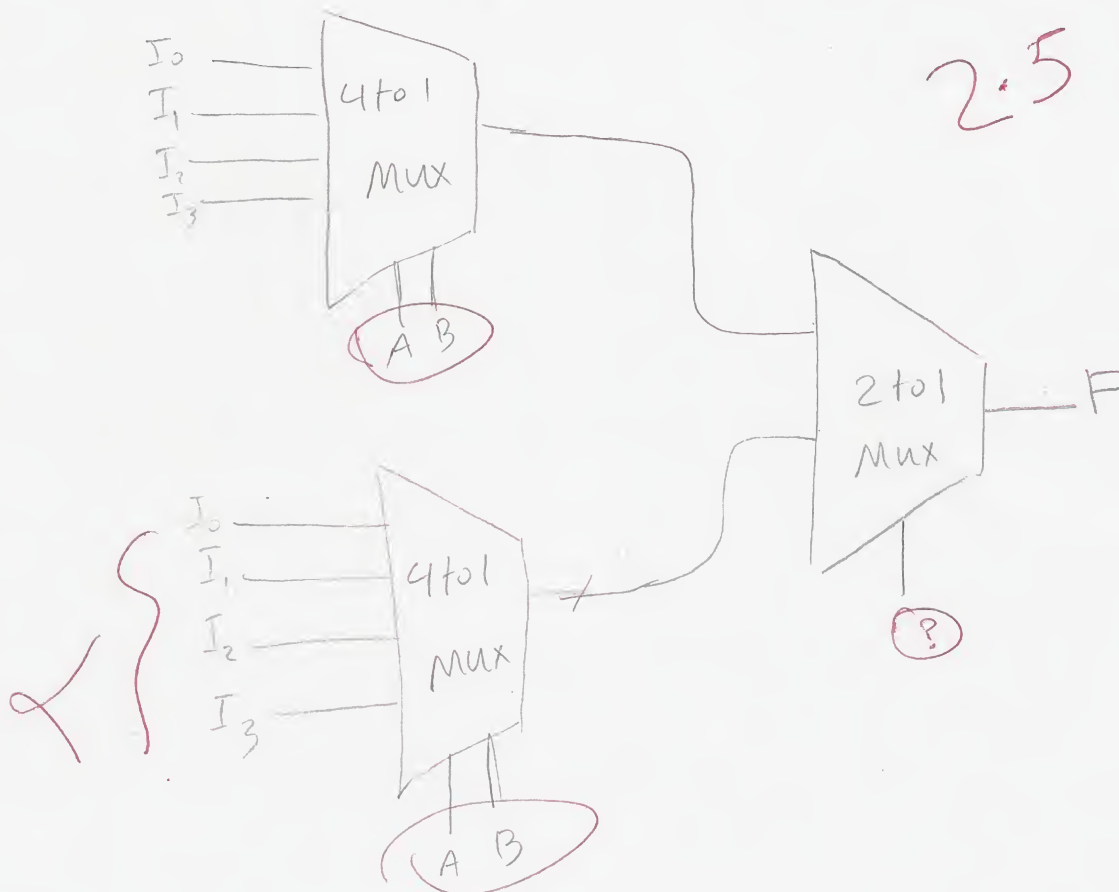
$$I_2 = 0$$

$$I_3 = \bar{c}d + cd$$

✓

8

- b. Show how to make an 8 to 1 Mux by using a number of 4-to-1 Muxs and one 2-to-1 Mux.



2.5

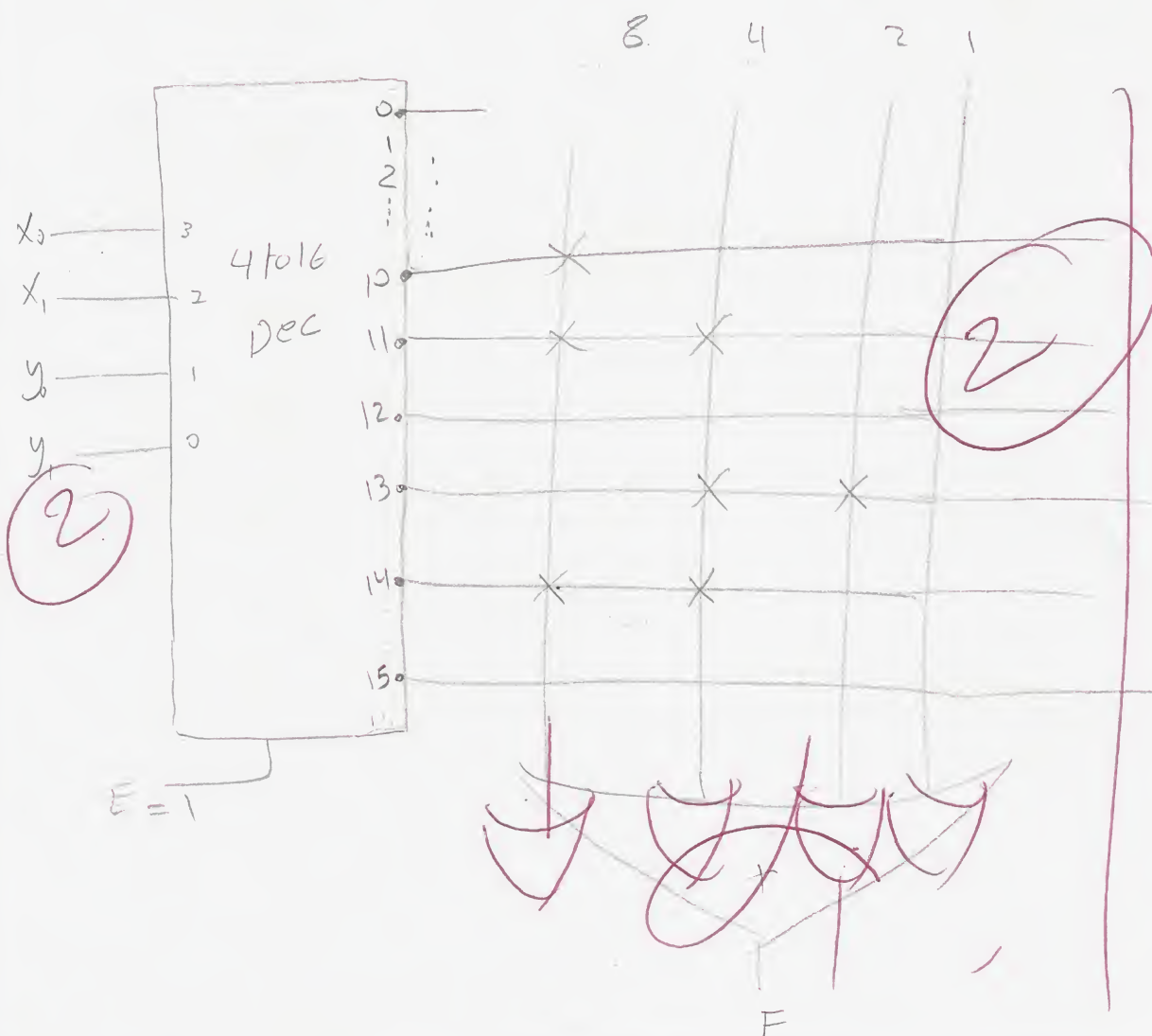
Question [4]: [12 mark]

a. Construct the truth table of a ROM to implement the function $F = 2 \times Y$. Where X and Y are 2-bit binary numbers.

X_2	X_1	Y_2	Y_1	
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	2
0	1	0	1	4
0	1	1	0	6
0	1	1	1	8
1	0	0	0	0
1	0	0	1	4
1	0	1	0	8
1	0	1	1	12
1	1	0	0	0
1	1	0	1	6
1	1	1	0	12
1	1	1	1	18

3

b. Draw the internal structure of the ROM showing only the last 5 memory lines (words).



Question [5]: [12 mark]

a) Derive the next state (characteristic) equation for T- Flip-Flop.

T	Q	Q ⁺
0	0	0
0	1	1
1	0	1
1	1	0

$$Q^+ = T \oplus Q$$

T	Q	Q ⁺
0	0	0
0	1	1
1	0	1
1	1	0

b) Complete the following timing diagram for the following J-K Flip Flop.

PreN	Clk	Q
0	0	Not allow
0	1	1
1	0	0
1	1	JK

JK	Q
00	No change
01	Reset
10	Set
11	T

